solplan review

the independent newsletter of energy efficient building practice

the drawing-room graphic services ltd.
box 86627 north vancouver b.c. V7L 4L2

No. 23 October-November 1988

INSIDE...

We are always interested in having a safe, healthy environment, especially inside our buildings. However, the question always arises: what does it mean? How will we know that we've achieved our goal? This is a difficult subject to grasp, as so much deals with subjective impressions.

Professor Fanger in Copenhagen has developed an approach to measure indoor air quality, taking into account the subjective feelings that must be dealt with. We present an overview of his work, and the terms for pollution that he has introduced. I think we will be hearing a lot more about *olfs* and *decipols* in the future.

Radon has become a hot topic, with many claims and counter claims being made. The public is getting upset but not sure where to turn to. As radon is a natural substance, found everywhere, there are no greedy corporate interests to take the blame. Radon can be a health risk where it is present in high concentrations. It is an issue that builders must come to grip with, as in most cases good construction practices will eliminate the problem. We present an update. Other topics include letters from readers, a review of a book about house building regulations, a review of the ENERPASS computer program for building energy consumption, how to build secure burglar-proof houses, and more.

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MEASURING INDOOR AIR QUALITY

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3921
Richard Kadulski

FROM THE PUBLISHER

As the Canadian election approaches, we are reminded that wrong or inappropriate policies can have devastating consequences on specific sectors of the economy. It is worth to consider several issues of interest to the building industry.

One is the direction of the second phase of the *tax reform* program. The chairman of the Parliamentary Finance Committee has admitted that the proposed value-added tax could generate an additional $10 billion in new taxes (that's over $400 per capita!). The proposed tax for *all* goods and services, when added to provincial sales taxes, is expected to be in the 16-23% range. It will tax virtually *every* business activity (even dental visits). The Canadian Homebuilders Association estimates this tax will add at least $9,000 to the cost of a new home. How many are going to be prevented from owning a home? In the face of such stiff tax increases, how is that going to affect public psychology? Will people continue to buy new homes and renovate existing? Or are we going to face a tax induced recession?

Another important issue is the Free Trade Agreement. Has the government provided you adequate in-depth information about the terms of the agreement and its meaning? There has been a lot of hype and praise about the concept. The details, however, are even more important. The consequences are going to be far reaching. Its implementation is going to take time as many laws and regulations have to be changed (the six month cancellation clause is good in theory - but not in practice).

Once in force, this agreement will take a life of its own so we'd better understand it before, not after. You don't give out blank signed cheques - why do so with this agreement?

Last time around we heard a lot about fiscal responsibility and the need to bring our deficit in line. This time they're falling over each other handing out money like drunken sailors. What about the money for economically unsound energy mega-projects that even the multinational energy companies did not want to touch (until they were handed pots of cash)?

As you get ready to make a decision, ask questions, and make your opinion known. Be sure you know where your candidates stand on issues of concern to you. The stakes in this election are more significant than they have been for many an election. Don't be caught off guard a month, or a year from now.

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SOLPLAN REVIEW is published 6 times per year by:
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Box 86627, North Vancouver, B.C. V7L 4L2
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205-1930 West Broadway
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ISSN: 0828-6574

SUBSCRIPTIONS: $30.00 per year. U.S.A. and other foreign subscriptions payable in U.S. funds or $36.00 Canadian.

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Printed in Canada
Second Class Mail Registration No. 6855
Postage paid in Vancouver, B.C.

Date of Issue: November 1988

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energy efficient building
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MEASURING INDOOR AIR QUALITY

This item may not yet be directly applicable to the active builder, but we feel that it represents a new way of looking at an important subject.

Measuring a subjective feeling is difficult - especially when it's about something that is so fundamental to our well being. We don't have think about breathing. Air is generally invisible, odourless and tasteless.

The concepts described here will have practical real world consequences as they are refined and find their way into standards, codes, and designs. While much of the research work to date is based on the office environment, the same principles apply to residences (in fact, our present standards for residential ventilation are derived from commercial standards).

This article is based on a paper presented by Professor Olf Fanger of the Technical University of Denmark.

Many people are often bothered by the indoor environment and feel relieved when they step outside. This dissatisfaction has been documented in hundreds of detailed field studies of offices, schools, homes and other non-industrial buildings in Europe, North America and Japan. Complaints include the feeling of stale and stuffy air, irritation of mucous membranes, headaches, lethargy, etc. These symptoms commonly describe what is referred to as the sick building syndrome.

The symptoms occur in nearly all indoor spaces. However, there is a wide variation in the number of people who are bothered - not everyone is equally sensitive.

In some buildings there may be obvious reasons for the poor air quality, for example when the air supply is less than designed. Most of the buildings studied in different parts of the world complied with existing ventilation standards. However, 20, 40 or 60% of the occupants typically found the air unacceptable. What is the source of the problem?

There are more than half a million smelly organic compounds. Many have a low odour threshold. Some are irritants with an irritation threshold much higher than the odour threshold. We have some knowledge on the odour and irritation characteristics of individual compounds, a little information on mixtures of two compounds, but no information that can help us predict a mixture of thousands of organic compounds, even if we were able to analyze the exact composition of the mixture. In other words the sum of the components is much more complex.

How then identify to and quantify the quality of indoor air when chemistry fails to help us?

The answer is to use man as a meter: we should recognize that man's nose is the most sensitive instrument available. This "instrument" in real buildings defines whether the air is fresh or stuffy, acceptable or unacceptable.

Due to the biological variation between human beings a panel of judges is normally required, preferably representative of a large population before a consensus can be reached.

The object of any ventilation standard is to provide acceptable air for the occupants. If this is not achieved there must be something wrong with the existing standards.

In offices, assembly halls and other similar non-industrial spaces it has been assumed that rooms and ventilation systems were absolutely clean and did not contribute to pollution and that man was the dominant or exclusive polluter. Mandated ventilation was thus specified per occupant.

Recently Prof. Fanger and his associates have identified severe pollution sources in spaces and ventilation systems by studying unoccupied office buildings.

How does one express a condition that is perceived by an individual - something very subjective?

Professor Fanger has created a unit of measurement he calls an **Olf**. The olf-unit makes it possible to quantify and compare different types of pollution sources. In one set of tests human bioeffluents or human generated olfs (i.e. smells and moisture generated by people), were found to be as little as 13% of the total pollution generated. Hidden olfs are believed to be the main reason for the sick building syndrome.

Fig. 1. One olf is the air pollution generated by one standard person, i.e. an average adult working in an office or a similar non-industrial workplace, sedentary and in thermal comfort with a hygienic standard equivalent to 0.7 bath/day.

What is an Olf?

Every person generates a plume of air around them. One olf is the emission rate of air pollutants from a *standard person*. Pollution sources are expressed by the number of standard persons (olfs) required to cause the same dissatisfaction as the actual pollution source. The olf is thus a relative unit, an attempt to measure a subjective feeling.

A human being was chosen as the reference because this has been considered as the main pollution source in ventilation standards for over a century. The intent is to express all pollution sources in olfs. For a given total pollution load in a space it is then possible to calculate the required ventilation to obtain the desired air quality.

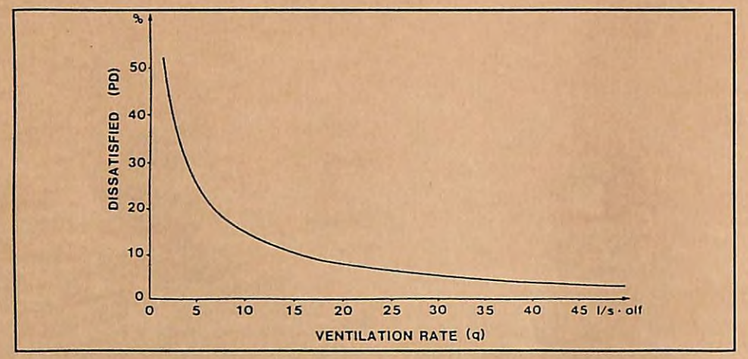


Fig. 2 shows how air polluted by one standard person (one olf) is perceived at different ventilation rates. It points out the number of people who perceive the air as unacceptable just after entering the room.

Table 1 lists olf values for different human pollution sources. As the olf concept is new only a few values exist at present but measurements of olf values for typical building materials and other pollution sources are now being collected.

Table 1. Olf-values for people

Sedentary person	1 olf
Active person 4 met	5 olf
Active person 6 met	11 olf
Smoker, when smoking	25 olf
Smoker, average	6 olf

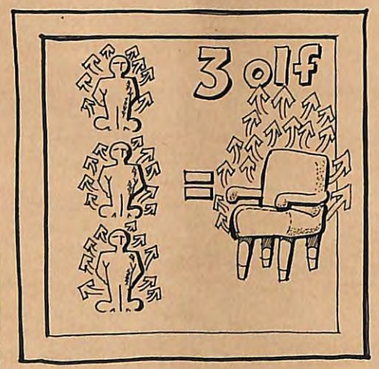


Fig. 3. A pollution source has a strength of 3 olf if the pollution from 3 standard persons causes the same dissatisfaction as the source.

The decipol

The concentration of air pollution is going to vary with the source of pollution and how well the ventilation flushes it out. The perceived air pollution is the concentration of human bioeffluents that would cause the same dissatisfaction as the actual air pollution. *One decipol* is the pollution caused by one standard person (one olf) ventilated by 10 l/s (20 cfm) of unpolluted air.

In healthy, well ventilated buildings with low pollution sources the perceived air pollution is less than one decipol (or less than 15% people are going to be dissatisfied). Spaces with low ventilation rates and strong pollution sources can easily have perceived air pollution rates of about 10 decipol (or 60% of the people are going to be dissatisfied). Air qualities around 0.1 decipol or 1% dissatisfied are common outdoors but are hard to establish in indoor environments.

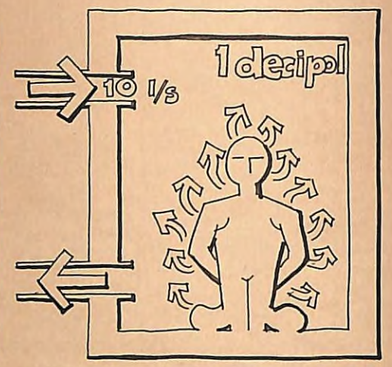


Fig. 4. One decipol is the perceived air pollution in a space with a pollution source of one olf ventilated by 10 1/s of unpolluted air. Steady-state conditions and complete mixing are assumed.

Prof. Fanger emphasizes that the decipol level only expresses the perception of the air quality by people, not whether the pollution is an actual health risk. Such risks must be considered separately. Our senses (with some exceptions) are also influenced by harmful pollutants, so they generally warn us against dangerous compounds in the environment. The perceived air pollution (in decipols) may in some cases also provide an early warning of a potential health risk.

A basic idea in ventilation standards since the 1850's has been that people should perceive the air quality acceptable from the first moment they enter a space. The first impression of the air (on entering a space) must be good.

If boiled cabages can be smelled on entering a space, it is not realistic to tell people not to worry about their first impression when they enter the house, but to wait a while until they get used to the smell.

This work by Professor Fanger may be used as the basis for future ventilation standards, as it recognizes (for the first time) that all pollution sources, not just people and smoking are important. It begins to quantify the quality of air as it is perceived by people.

The first step in a ventilation standard is to determine the desired air quality in the space to be ventilated. This is already done in the ASHRAE ventilation standard which specifies that the air quality should be acceptable to 80% of the occupants. This corresponds to 20% dissatisfied or 1.4 decipols. A future standard may very well specify different air qualities for spaces with different uses.

The next step is to estimate the quality of the outdoor air available for ventilation of the space. In many cases the perceived outdoor air pollution is negligible compared to the indoor level. Only if the outdoor pollution is severe may it be necessary to clean the outdoor air before it is suitable for ventilation.

The third step requires an estimate of all the pollution sources in the space and the corresponding ventilation system. Table 2 shows an example of estimated olf-loads in offices (per m^2 of floor area).

TABLE 2

Olf-loads in offices per m^2 floor area.

Pollution source	**Olf/m^2**
Occupants (one person per 10 m^2)	
Bioeffluents	0.1
Additional load	
from 20% smokers	0.1
40% smokers	0.2
60% smokers	0.3
Materials and ventilation system	
Average existing buildings	0.4
Low-olf buildings	0.1
Total load in office buildings	
Average present building stock	
40% smokers	0.7
Low-olf buildings, no smoking	0.2

The estimated pollution loads are based on a field study of 15 randomly selected office buildings in Copenhagen. Substantial pollution levels were found in the unoccupied buildings. The average pollution load was 0.4 olf/m^2 with a range of 0.1-0.9 olf/m^2. The pollution was generated by all kinds of building materials, furniture, carpets, books and office machines. Surprisingly a major contribution came from the ventilation systems themselves.

When designing new buildings, strict attention must be paid to materials used. Ventilation systems should be designed with a low olf-value when new, and a rigorous maintenance scheme be prescribed to keep it so during its lifetime. In this way low-olf buildings can be built with pollution loads of about 0.1 olf/m^2 from materials and ventilation system.

The estimates of pollution loads in olf/m^2 are similar to rough estimates used for heating or cooling loads in buildings expressed in W/m^2.

An olf-catalogue listing properties of different materials does not exist yet, but would be useful for design and selection of materials. Such a listing would be similar to the tables of thermal properties of materials.

Using such guidelines, ventilation requirements for office buildings can be determined. To obtain an indoor air quality of 1.4 decipol a ventilation rate of 5 1/s m^2 is required for average existing office buildings. This is three times higher than prescribed by any existing ventilation standard. Such an increase in ventilation is not the easy way to go. Rather, the obvious alternative is to reduce the unnecessary hidden olfs. This will improve indoor air quality, decrease required ventilation and energy consumption, and diminish the risk of drafts at the same time.

The key getting acceptable indoor air quality at a reasonable ventilation rate is thus to keep the olf-load in the building as low as possible. Thus the design, development and maintenance of low-olf buildings is the fascinating challenge for the future. It is the obvious way of improving indoor air quality to prevent sick buildings.

This approach is not really as off the wall as it may sound. The two units for air quality that are being proposed, (the *olf* and *decipol*) correspond to similar units for that measure apparent light intensity (the *lux*) and noise levels (the *decibel*.)

When light and noise were first measured, they relied on human beings as the meter. Later, over time, instruments were developed with built-in information about the sensitivity of the eye and the ear.

In a similar way, at the moment we can only measure olfs and decipols by using man as a meter. This means using a panel of judges. The next challenge is to develop an instrument to measure the perceived air pollution - a decipolmeter.

TABLE 3 Office Building Ventilation Requirements

Assumes 0.1 person/m^2 and negligible outdoor air pollution

Indoor air quality = 1.4 decipol	L/s-m^2
Exist smoking building (7 olf/m^2)	5
Low-olf (non-smoking) buildings (0.2 olf/m^2)	1.4
ASHRAE Standard 62-81	
Smoking	1.7
non-smoking	0.25
Scandinavian Guidelines	
smoking	1.0
non-smoking	0.4
DIN 1946 Standard (large offices)	
smoking	1.9
non-smoking	1.4

This material was published in a paper titled **A Comfort Equation for Indoor Air Quality and Ventilation** *written by Professor P.O. Fanger, Laboratory of Heating and Air Conditioning, Technical University of Denmark. It appears in the Proceedings, Healthy Buildings '88 Conference, Stockholm (Sept. 5-8, 1988).*

RADON: AN UPDATE

Richard Kadulski

Radon has gained a high profile recently, especially when the U.S. Environment Protection Agency suggested all houses should be tested for radon. The 1990 proposed revisions to the National Building Code of Canada include revised foundation construction details intended to deal with radon.

This increased profile has already attracted the fast-buck charlatans. In Vancouver (an area where testing has not detected radon in any serious concentrations) a huckster has started a promotion for a radon testing service even though he admits he doesn't know what kind of radon levels may be found in Vancouver area houses (and probably less about the subject). He's doing it just because of the EPA announcement.

The problem is that there is no adequate infrastructure in the market to tackle testing and remedial action on the scale suggested. Nor is there an adequate protection mechanism to protect against fraud and other abuses.

What is radon?

Radon is a colourless, odourless and tasteless radioactive gas that is impossible to detect without some form of measuring apparatus. It is a natural radioactive decay product of radium, a decay product of uranium, which is present in small amounts in soil and rock throughout the planet. Radon is nine times heavier than air, so it tends to remain close to the ground.

According to a study carried out in Ottawa, radon levels in the basements of a group of houses were, on average, two to five times higher than the levels on the upper floors.

Radon by itself is not a health risk. However, it is not a very stable element with a half-life of 3.8 days (that is, in a given concentration, one half the quantity of radon molecules will decay in a period of 3.8 days).

Radon daughters, the decay products of radon, are unstable radioactive particles. It is Radon daughters that are of concern to health. Radon gas may be breathed in by a person. By itself it doesn't do anything. But if the radon decays when it's in your lung, it becomes a radon daughter. These unstable compounds can be inhaled and deposited in the lung. The subsequent release of energy during the remaining decay steps can cause damage to surrounding tissue and can lead to lung cancer.

Radon and its various daughters can all be present at any time. Since radon daughters have an electrical charge, they tend to attach themselves to surfaces, including walls, furniture, and airborne dust particles. When attached to large surfaces (a process called plate-out), they no longer represent a health risk since they cannot be inhaled. If they are not attached to anything or are attached to small airborne dust particles, however, they may be inhaled.

What is the health risk?

There is little debate as to whether exposure to radon and its decay products increase the risk of lung cancer. The major debate is about what the risk associated with different levels of exposure is. Most data available is related to studies of miners who are exposed to short duration of high concentrations for a few years. However, the consequences of long term exposure to low concentrations (as may happen in a house) are not as well understood. Nor is there any conclusive evidence.

There is evidence to show that high concentrations can build up inside a house if the conditions are appropriate. The whole issue of radon was discovered by accident a number of years ago in the Eastern U.S. when a worker at a nuclear plant *tripped the radiation alarms on the way into* the plant. After some investigation it was discovered that the radiation source was the worker's house which had extremely high radon levels. (It happened that the house was built on solid rock which had a uranium vein running through it).

Houses are not the only building type subject to radon exposure. Recent studies of a number of schools in the Washington D.C. area have shown some alarmingly high radon concentrations.

The World Health Organization has concluded that radon is responsible for about 10% of all lung cancers.

How is Radon Measured?

Radon gas levels are normally expressed in picocuries per litre of air (pCi/L), Becquerels per cubic metre (Bq/m^3) or Working Levels (WL). Each is a measure of the total number of particles emitted during the radioactive decay process.

How much is acceptable?

To date Canada has not established definitive radon exposure guidelines for homes. The guideline being suggested for homes is .2 mWL. The proposed ASHRAE standard has a value of 27 mWL.

The U.S. EPA guideline suggests that mitigation be undertaken in houses with annual average radon concentration in air exceeding 4 pCi/l. However, there is no clear consensus as to what is a safe level.

Table A lists the levels at which various government agencies and private groups recommend doing remedial work to lower indoor radon.

1 pCi/L = 37 Bq/m^3

The Working Level is a measurement introduced by the uranium industry to provide an indication of risk to miners. It measures the maximum concentration that a miner is allowed to work in.

The ratio between radon and radon daughters varies, but the approximate relationship is:

800 Bq/m^3 = 20 pCi/L = 0.1 WL

TABLE A

Organization/Country	Action Level (pCi/l)
Sweden (for existing buildings)	11
Health and Welfare Canada	10
National Council on Radiation Protection (USA)	8
Florida Environmental Protection Agency	6
Sweden (buildings under renovation)	5
United States Department of Energy (DOE)	5
Union of Concerned Scientists	5
United States Environmental Protection Agency (EPA)	4
Sweden (for new construction)	2
American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)	2

Testing for Radon

There are four common testing procedures for Radon.

1) a continuous radon monitor measures concentrations over a period of hours to days. This method can provide results immediately, and can track variations in concentration. It is accurate for a 24 hour test or longer. However, this test method requires expensive equipment that must be carefully maintained and calibrated by trained operators.

2) Alpha-track detectors measure radon particles over a longer period of time (up to a year). At the end of the test period the detectors are returned to a laboratory for analysis. This is an easy test to use, not temperature or humidity sensitive, requires no power, and is fairly accurate.

3) Grab Sampling measures air samples over a quick period of time (usually several minutes). A known volume of air is pumped through a filter which is then analyzed. The tester can note the exact weather conditions during the test. It is quick and easy to use. However, short term measurements are not a long term indicator of radon levels.

4) Activated charcoal monitors are passive detectors to measure radon concentrations over 3 to 7 days. Analysis is done in a laboratory. This is a quick, inexpensive, easy to use and accurate method. However, this test method is sensitive to temperature and humidity.

Where is radon found?

Radon is often found in areas where mine tailings have been used as fill, or in areas close to uranium mines. But it is also present in many other areas. The geology of the area is the critical factor. It is not just the mineral rich areas that may be at risk - some of the highest levels of radon measured in Canadian homes have been in prairie cities (including Winnipeg, Regina, Brandon). As radon concentrations are so variable, dependent on house and soil characteristics, it is not possible to make a blanket statement about where radon might be a concern. However, some geographical areas are generally more prone to higher radon concentrations than others.

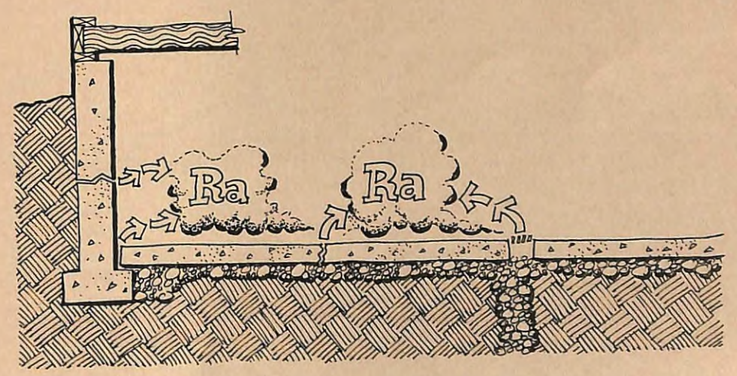
Soil surrounding foundations is usually the most important source of radon. Across Canada, soils that have been assessed show as much as a 35 to 1 variation in radium content.

Major pathways by which radon gas can enter a building are through the foundation wall or floor cracks, joints and plumbing penetrations. Crawlspaces and areas with exposed soil may also facilitate the transport of soil gas. The transport process will increase if the building is depressurised relative to the gas in the soil.

Water can contribute to elevated radon levels, especially when radon concentration in the water supply exceeds 10,000 pCi/L. The problem may be a special problem in houses that have their own water wells (some localized areas may have well water with a radon content of over 100,000 pCi/L). Radon gas may be released into the air when the water is boiled, used in a shower or otherwise agitated. How-ever, most water supplies have radon concentrations less than 1000 pCi/L.

Building Materials

There are some instances where building materials have been noted to



have high radon concentrations. Materials such as concrete, brick and tile usually have radiation concentrations similar to those of the major rock types used in their manufacture, and because of this may show large geographical variations. Except for isolated cases, they have not proven to be major radon sources.

Radon Control

As with any pollutant, efficient radon control should seek first to minimize the pollutant source. Secondary control measures, including improved ventilation, can then be applied to ensure that the radon concentration is maintained at an acceptable level.

New Construction

A number of measures have been used to minimize radon entry into houses. In one extreme case in northern Saskatchewan at the site of a uranium mine the workers' living quarters were built on stilts, about 2.5 metres above the ground, because of high ambient radon concentrations at ground level. A less extreme option in areas with lower radon concentrations is to build a house on a well ventilated crawlspace. For those who use a basement in areas with high radon levels it is important to exclude radon gas entry by carefully sealing leakage paths.

Most techniques for excluding radon are simply good building practice. For example, cast concrete walls and floors should be designed to withstand soil stresses and minimize cracking. A layer of polyethylene should be placed underneath a concrete slab before it is poured. Although some diffusion of radon can occur through it, the polyethylene can limit the convective flow of radon gas. The joint between the floor slab and the concrete wall should be properly sealed. To limit entry of radon gas from weeping tile, open air flow paths between the weeping tile and the floor drain should be avoided.

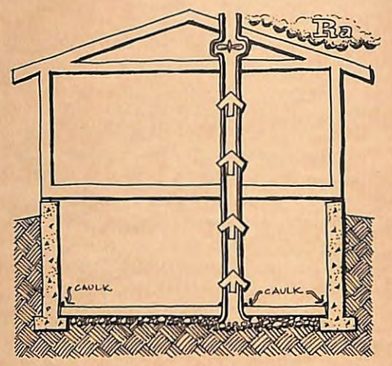
Houses with a crawlspace should have a polyethylene moisture barrier placed on the crawlspace ground surface. The polyethylene sheet will limit the migration of air carrying radon into the crawlspace and from there into the living space.

A balanced ventilation system is also useful for controlling radon gas levels in the houses with moderate radon sources. The National Building Code of Canada 1985 now recommends an installed capacity of 0.5 air changes per hour. In areas of high radon concentration, however, ventilation alone is usually not sufficient to reduce radon levels to recommended levels. Unbalanced ventilation systems that depressurize the building envelope can increase radon entry rates through leakage paths and interfere with the proper operations of combustion appliances. Building pressurization can reduce radon entry, but may also result in other problems including moisture migration into the building envelope and freeze-up of chimney in cold weather.

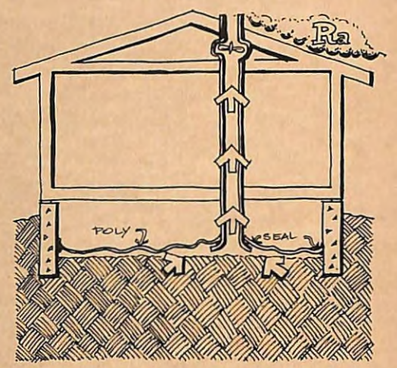
Draft-free energy efficient R-2000 houses have generally shown to have a much lower radon levels.

Remedial Measures

There are several means of reducing radon levels in existing houses:
* Seal cracks in basement floors and walls, and block air flow through some pits and floor drainage holes.
* Cover crawlspace floors and ventilate the crawlspace.
* Increase ventilation in the house, often with an air-to-air heat exchanger to reduce the cost of providing the extra ventilation.
* Vent the space beneath the concrete floor to remove radon gas and create a pressure differential across the concrete slab that will cause basement air to exfiltrate through cracks and other openings in the concrete slab. Sub-slab venting is perhaps the best, most proven way of dealing with the issue.



Subslab ventilation after all potential radon gas entry points are caulked and sealed is an effective remedial action. The vent pipe must be tightly sealed. A good quality fan, running continuously is used to generate the required pressure to exhaust radon gas.



A crawlspace with high radon concentrations can be vented in a similar fashion, by sealing and caulking a polyethylene membrane over the soil, and venting the area beneath by a good quality fan (running continuously).

Conclusions

At the present time there are no accurate methods of predicting radon levels in homes. Although certain geographic areas and construction practices appear to contribute to elevated radon levels, similar houses within a single neighbourhood can have indoor radon levels that vary by a factor of 20 or more. Careful attention to construction details that minimize soil gas entry points and properly designed and maintained ventilation systems will help reduce potential radon problems.

The only method of determining the indoor radon concentration is to have it measured. As with all measurements, however, their accuracy and frequency will influence the conclusions reached. Skilled, experienced personnel are required to evaluate a building system and test data.

More information

Information regarding the implications of radon levels on human health can be obtained from the Environmental Radiation Hazards Division, Bureau of Radiation and Medical Devices, Health and Welfare Canada, Ottawa, K1A 1C1.

Additional reading:

** <u>Radon : The Invisible Threat</u> by Michael Lafovre, a readable book, published by Rodale Press $15.95 (available from The Drawing Room)*

** <u>Practical Radon Control for Homes</u> by Terry Brennan and Susan Galbraith, published by Cutler Information Group, US$40.00 plus $3.00 shipping. (Cutter Info Corp. 1100 Massachusetts Ave. Arlington MA 02174)*

** <u>Radon Control in New Houses</u> a Builders' Series handbook published by Canada Mortgage and Housing Corporation ($1.00) This publication was developed for a builders' workshop series to be held across Canada.*

A detailed radon mitigation course is being prepared by CMHC and should be ready next year.

RADON RISK EVALUATION

CONCENTRATION		EXPOSURE LEVELS RISK RADON	COMPARABLE RISK	EST. NO. DEATHS (due to radon/1000)
200 pCi/L	1 WL	1000 times average outdoor level	60+ times more than than non-smoker	440-700
100	.5	100 times avg indoor level	4 pack a day smoker	270-630
			20,000 chest x-rays/year	
40	.2		2 pack a day smoker	120-380
20	.1	100 times avg outdoor level		60-120
			1 pack a day smoker	
10	.05	10 times avg indoor level		30-120
			5 times non-smoker risk	
4	.02		200 chest x-rays/year	13-50
2	.01	10 times avg		7-30
1	.005	average indoor level		3-13
.2	.001	average outdoor level	20 chest x-rays/year	1-3
		outdoor level		

adapted from EPA & CMHC publications

Radon Detectors

The following supply simple charcoal or alpha-track radon detectors:

Alpha Nuclear, 1125 Derry Rd. East Mississauga, Ont. L5T 1P3 (413) 676-1364

Barringer Laboratories, 5735 McAdam Rd. Mississauga, Ont. L4Z 1N9 (413) 890-8566

JRW Industries, 2312 N. Second St., Harrisburg, PA 17110 USA (717) 236-1418

Key Technology Inc., Box 562, Jonestown, PA 17038 USA (717) 274-8310

Terradex Corp. 460 N. Wiget Lane, Walnut Creek, CA 94598 USA (415) 938-2545

LETTERS TO THE EDITOR

Sir,

I was glad to see that Jim Marke looks closely at windows when it comes to maximizing energy performance of his houses. I'm convinced that windows offer one of the most cost effective places to invest in energy efficiency in new construction. We may have different windows available in Oregon than he has in Alberta so the following comments may not apply to his situation, but I'm sure they apply in many parts of North America.

First, I don't feel that it's particularly helpful to compare triple and low-e glazing based on generic R values (or U-values). When tested U values are compared, many double glazed low-e windows have far superior U-values compared to many triple glazed windows. Even with the better shading co-efficient of the triple glazed units, there are many low-e units that would perform better than most triple glazed units. The lesson here is that tested U-values of actual units under consideration should be used in these types of comparisons (computer simulations).

Second, the cost of low-e glazing in efficient window frames is usually significantly less than the cost of triple glazing here in Oregon. In fact comparable performance is often available in low-e windows for several dollars per square foot less than triple glazing. The largest savings projected by HOT-2000 was less than $40 per year. That would need to be matched to the added cost of the triple glazing (which could be well over $1000 on a typical house). The lesson here is that the actual costs of various windows should by compared along with the tested U values before deciding on triple glazing or low-e.

Third, the shading co-efficient used for triple glazing is a very favourable one. ASHRAE rates the transmissivity of 1/8" glass between .91 and .86. This would result in a shading co-efficient ranging between .83 and .74. An average would be closer to .78 than the .8 used in Mr. Marke's HOT2000 runs. What would the results have been if an R-value of 3 had been used for the low-e window (widely available in the Pacific Northwest) and a shading coefficient of .78 had been used for the triple glazed window? The triple glazed window would still have a slight edge in absolute performance, but the low-e window would likely have a significant advantage in price/performance.

Finally, what I feel is most important is that builders look for the most energy efficient marketable window they can find. Marketable means affordable energy efficiency and that could mean low-e or triple glazing depending on local availability. In Oregon, low-e windows are available which are very close in performance to the best triple glazed windows and are very much lower in price. Perhaps that's different in Alberta, in which case triple glazed windows would be the better choice.

Ted Haskell
Extension Energy Agent
Oregon State University
Portland, OR.

Sir,

I read with interest the Article by Jim Marke on Low-e vs. triple glazing *(SOLPLAN REVIEW #22)*. He concluded his article by challenging the promoters of Low-e, stating we "have much to answer for". At Repla we have been promoting Low-e since 1983, and gas filling since 1986, so Jim Marke was talking about us, among others. So here's the reply.

First 'average energy consumption reduction' comparisons for windows are perilous waters at best. They are extremely sensitive to even slight changes in both R-values and degree days, and shading coefficients and solar radiation.

I use a simpler tool than HOT2000 to do this type of analysis. It is described in a paper written by S.A. Barakat: "Comparison of the Thermal Performance of Glazing Systems". It is not house specific, so it makes a few more assumptions than HOT-2000. It can be used in a spreadsheet, so the effects of changes in inputs are easy to see.

This is useful since there are wide variations in input data. Jim Marke quotes a shading coefficient of 0.66 for low-e, while the VISION program calculates 0.73, and PPG claims 0.76. Choosing either extreme in shading coefficients and similar extremes for U-values can make your favourite glazing look good or bad.

For example south facing double glazing in Toronto can either be slightly better or much worse than Low-e, depending on which shading coefficient is used.

In addition each manufacturer uses a different coating, so there are slight differences between in performance between brands of Low-e. And there are even differences from batch to batch for each manufacturer (sometimes the glass is better than advertised).

With these variations in and sensitivities to input data, it is clear that general rules of thumb are only as useful as their assumptions. Since advanced computational simulation packages are available, they should drive the design of specific buildings. But the strict assumptions necessary for computer simulation must be relaxed before the results can be used as rules of thumb.

Now that I've muddied the numerical waters, I'll throw in some of my own figures. Using the Barakat method and Toronto weather data I did some simple comparisons. Triple glazing out performed low-e by about 10% on east, south and west, on the north they are even. Low-e argon filled glazing outperformed triple glazing by 100% on the north, 25% on east and west and 10% on the south.

As Jim Marke points out, performance is not the only factor to consider in buying windows. Triple glazing is heavier that double glazing so even with heavier hardware, opening windows are smaller, and more prone to problems in their 2nd and 3rd decades. In addition, a triple glazed unit has four seals, twice as many as a double glazed unit, so it is more likely to fail.

From a cost viewpoint, once a manufacturer embraces Low-e, the windows, even when gas filled, cost about the same as triple glazed windows.

In his closing Jim Marke says "If I had the choice (which due to cost factors, I don't) I would seriously consider using double glazing with argon fill..." This deserves two comments. First gas filling is cheaper than nearly anyone expects (just check out the price of argon). Second and more importantly, gas filling double glazing only increases its R-value from 2.0 to 2.2. Most of a window's heat loss is due to radiation. So unless a sealed unit includes a Low-e coating then gas filling is pointless.

To summarize make your best guess at the input data, do the analysis and Low-e Argon filled glazing will likely be the winner.

Stephen Thwaites
Repla Ltd.
Oakville, Ont.

ODDS 'N ENDS

"EXCELLENCE IN HOUSING '89, Building for Health, Durability and Affordability" will be the theme for the 7th Annual Energy Efficient Building Association Conference, in Winnipeg, Manitoba, March 2-4, 1989. It will be the first time it has been held in Canada.

Conference organizers expect over 500 builders, designers, developers, engineers, architects, retrofit specialists, utility and government representatives, educators, building material suppliers and others related to the quality, energy efficient building design and construction industry will attend this meeting.

Those interested in delivering a technical paper and/or a case study appropriate to the general conference theme should forward a 1-2 page type written abstract for the consideration of the Selection Committee. Abstracts are due not later than November 7, 1988 at EEBA Headquarters.

For further information, contact:
Howard M. Faulkner, Executive Director
Energy Efficient Building Association
Headquarters
University of Southern Maine
Gorham, Maine 04038 USA
Tel (207) 780-5143
Fax (207) 780-5129

A design competition for an Energy Efficient Residence (new or retrofit) will also be held. The residence must have been occupied for at least one year as of December 1, 1988 to be eligible for consideration. The winner will receive this annual award at the Conference in Winnipeg. Those interested in completing a comprehensive application for this award should do so before November 18, 1988, by contacting:

1988 EEBA Design Competition Committee
BILL EICH, Chairman
Box 63
Spirit Lake, Iowa 51360
Tel: (712) 336-4438

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Solar Energy Society of Canada
3 — 15 York Street
Ottawa, Ontario K1N 5S7

NEW NAME AT ORF

The Ontario Research Foundation (ORF) has changed its name, and will now be known as:

ORTECH International.

The organization is a comprehensive technology consulting enterprise. To the low energy building community one of its most known activities is the testing of heat recovery ventilators.

RENEWABLES: a clean energy solution
1989 LEBCO SYMPOSIUM

The 1989 **LEBCO low energy building forum** will deal with environmentally appropriate energy development. Invited speakers will approach the issue of a healthy environment from 2 points of view. On the one side, the issue of a healthy environment worldwide will be discussed (the greenhouse effect and what it really means to us).

On the other, will be invited speakers of special interest to the building community. They will bring the global environmental issues down to earth, how to make buildings healthy. Invited speakers will include specialists:some that seldom talk to each other.

Speakers will include medical specialists involved with allergy problems, builders who have had hands-on experience with the chemically sensitive, ventilation experts on appropriate strategies, and mechanical systems suppliers, as well as homeowners with special concerns.

Technical papers on energy conservation and renewable energy research and development are being solicited.

The conference will be held in Penticton, B.C. (in the heart of the Okanagan Valley) 250 miles east of Vancouver, June 19-21, 1989.

Mark your calendar today, and plan to attend.

For details, contact:
Solar Energy Society Of Canada Inc.
3 - 15 York, Ottawa, Ont. K1N 5S7
Tel: (613) 236-4594

BOOK REVIEW

House Building Regulations Simplified:

an illustrated commentary on house building regulations in Canada
J.C.Currie and J.S.Roberston

For smaller buildings the standards and regulations of the building code are followed religiously, to become the accepted practice, seldom exceeded or deviated from. Builders often are not comfortable enough with the code to deviate from standard work practices to improve their product or incorporate simpler techniques.

Unfortunately, few builders or designers really bother to read the code or understand the underlying thinking that went into the writing of the code. Granted, the Building Code is not bedtime reading unless you suffer from insomnia, at which time it is guaranteed to put anyone asleep. As the code has to cover all possible situations, it is usually very general in nature and difficult to comprehend. However, it does set out the manner by which buildings are to be put together.

The intent of the code is to protect the health and safety of the users of buildings. However, it may come as a surprise to many that the Code contains a lot of information that can be useful if it can be deciphered.

The National Building Code of Canada recognizes that there is a difference between the construction of large commercial and institutional buildings and small buildings. As a result, Part 9 of the code is devoted to small buildings. Since a large proportion of people building small buildings and especially houses (which come under provisions of Part 9) are less skilled or total novices, it contains more detail than other sections of the code (which rely to a greater extent on standards and practices to be followed by professionals).

Housebuilding Regulations Simplified has been written to make it easier to understand Part 9. It lives up to its name. It is an illustrated commentary on the 1985 edition of Part 9 of the National Building Code. It does not deal with variations that have been adopted by various local jurisdiction.

However, these are usually relatively minor.

This book only covers ordinary, single detached houses. It does not deal with issues that are specific to more complex and multiple dwellings. The book gives a detailed analysis of the code - providing background information on the meaning and intent of specific code sentences. The commentary should also help reduce misunderstandings that may arise between builders and inspectors (assuming both have read it!).

The organization of the book does not follow the code, but rather standard construction practice. Every code article referenced in the book is indexed for easy access (by article number and topic).

A picture is worth a thousand words. The authors not only explain the code in words, but also with a picture wherever it will help. The pictures are simple, but clear. Unfortunately, there are not as many illustrations as there could have been, but the book goes a long way to clarifying many code sections.

Don't look for a detailed explanation of the ventilation requirements (Section 9.33.3). This part is very meagre and does not match the standard in the rest of the book. (The latest revisions to this section by the province of B.C. go a lot further, even without extra explanation).

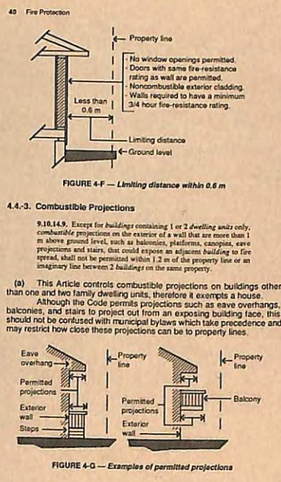
However, given the complex nature and variety of subjects covered, the shortcomings in dealing with ventilation section are a small point. This book is still well worth the investment.

This book is not meant to be read at one sitting but used as a reference book. Anyone involved with home building (construction, design or inspections) will find much of use to them even if they don't use the National Building Code.

The authors are technically knowledgeable. Jim Currie is the retired director, and Jack Robertson is his successor at the B.C. Building Standards Branch (the agency responsible for the Building Code in B.C.).

If there is one criticism, it is that some of the language used in the book is highly technical, making it difficult to read at times.

Copies are available for $54.00 (shipping included) - volume discounts are available.
Contact:
C-Text Inc., Box 5968 Station B
Victoria B.C. V8R 6S8


40 Fire Protection

Property line

No window openings permitted.
Doors with same fire-resistance rating as wall are permitted.
Noncombustible exterior cladding.
Walls required to have a minimum 3/4 hour fire-resistance rating.

Less than 0.6 m

Limiting distance

Ground level

FIGURE 4-F — *Limiting distance within 0.6 m*

4.4.-3. Combustible Projections

9.10.14.9. Except for *buildings* containing 1 or 2 *dwelling units* only, *combustible* projections on the exterior of a wall that are more than 1 m above ground level, such as balconies, platforms, canopies, eave projections and stairs, that could expose an adjacent *building* to fire spread, shall not be permitted within 1.2 m of the property line or an imaginary line between 2 *buildings* on the same property.

(a) This Article controls combustible projections on buildings other than one and two family dwelling units; therefore it exempts a house.

Although the Code permits projections such as eave overhangs, balconies, and stairs to project out from an exposing building face, this should not be confused with municipal bylaws which take precedence and may restrict how close these projections can be to property lines.

FIGURE 4-G — *Examples of permitted projections*

ENERPASS BUILDING SIMULATION PROGRAM

Good heating, cooling and ventilation system design will produce a comfortable building. Reliable, easy to use tools are very valuable. Many handbooks were developed over the years to help designers. Computer software has made it possible to take advantage of state-of-the-art knowledge to do detailed and accurate calculations in just a few minutes.

Widespread simulation of houses was only seriously started in the 1970's when the energy crisis spurred the need to know just how effective alternative energy and energy conservation measures were.

One of the first personal computer programs developed to deal with residential buildings was HOTCAN, for use by the R-2000 Program. It is simple to use and can quickly produce results that are reasonably accurate.

The HOTCAN program was upgraded (now called HOT-2000). It is a more refined version that also simulates the performance of mechanical systems. This software provides an average monthly energy balance to determine energy requirements for space heating and water heating.

For design purposes these are adequate to determine optimum insulation levels, total heat loss for sizing heating systems and the relative value of alternative mechanical systems. They cannot tell you when you need the heat most or when (or if) it will overheat.

ENERPASS is a more sophisticated program for estimating building energy consumption.

What does Enerpass do that HOT-2000 can't?

ENERPASS can model up to four different zones. For example, a house with an attached sunspace may be split into zones as follows: the main floor south side, the main floor north side, the basement, and the sunspace. This kind of breakdown can provide detailed analysis of how solar gains are distributed in the house.

ENERPASS can do detailed hour-by-hour simulation over the full year (which may take as long as 2 hours to calculate) or over a few days only, or for the typical design day only. The user decides.

Hour-by-hour performance provides precise information on the building performance. For example, how many hours per day (or month) is a zone above or below a certain temperature? This is the information that can tell you whether or not a full cooling system may be needed. Let's say that in July and August for 100 hours the temperature is between 26°C and 28°C and for 25 hours will reach between 28°C and 30°C. Will this justify spending $5,000. for an air conditioner? Is there something else that can de done to change the amount of time the house sees these temperatures? Maybe this situation is satisfactory.

Hourly simulation allows modelling of variable, time dependent energy use (e.g. time of day energy loads). This is important where energy is sold on a demand or time-of-day basis.

Each module of ENERPASS is accessible, so you don't have to run through the whole program if you only want to edit one or two parameters. A regular user will find this usefull, as the defaults are set by the user, you don't have to go through reams of inputs that are not applicable to do a specific run.

As the program run time is long (a simple calculation may take 10-15 minutes or more) you can prepare several files, for instance several different alternatives being investigated. They will then be calculated in sequence (over lunch or overnight).

Weather data is available for 17 Canadian and 13 U.S. cities. Data for additional locations may be available but has to be converted to Enerpass format.

How accurate is ENERPASS?

It has been tested by the International Energy Agency. The test involved comparing known performance of several houses against ENERPASS predictions. Calculations were also compared to results of complex mainframe programs that are used as the standard. It was found to accurately perform simulations.

Who's this program for?

Anyone who is actively involved with mechanical design will find ENERPASS very useful, but it demands more technical expertise to use than HOTCAN (the user manual is complete but not overly user fiendly).

Builders and designers will get most of the information they need from a simple program like HOTCAN or HOT2000. But for those projects that require special attention: where cooling or unique design features are a factor, or to evaluate alternative mechanical systems, ENERPASS is a good tool to use.

Any designer or consultant involved with smaller buildings should seriously evaluate this program, as it may become an indispensable tool.

ENERPASS models:
* up to 4 separate zones (including heat transfer between zones
* heating, ventilating, air conditioning systems, zone controlled or central heating
* humidifying effects including mechanical humidification and dehumidification
* heating system types include electric baseboard, forced air furnace, heat pumps
* heat recovery ventilators
* solar gains through skylights
* design day or hour-by-hour calculation of building temperatures, heating and cooling energy consumption
* night setbacks
* timed mechanical operation

ENERPASS v.2.1 $350.00
Minimum equipment requirements:
IBM - PC with 256K RAM
(math co processor will speed calculations)
Demo disk available

Further information:
Enermodal Engineering Ltd.
368 Philip St. Unit 2, Waterloo, Ont. N2J 5J1
Tel: (519) 884-6421

SECURE BUILDINGS BY DESIGN

Burglary is becoming serious in some urban areas. As a result of a police sponsored campaign, measures to "burglar proof" houses by improving the resistance of dwelling units to break and entry were implemented in the 1985 edition of the B.C. Building Code. These are now being proposed for the 1990 edition of the National Building Code.

Police forces stress types of preventive measures as statistics show that 90% of residential break and entries are done by non-professional burglars who do not have special skills, but are taking advantage of poor design and construction methods.

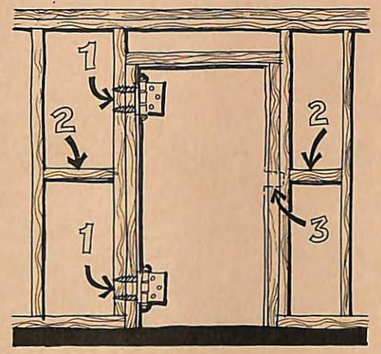
The key provisions of the proposed security package focus on exterior doors, requiring that they all be solid core with dead bolts (1" min. throw); wood door hinges fastened with wood screws not less than 1" long to the door and to wood frames at least 2 screws per hinge be 1¼" long. (Metal doors and metal frames require minimum ½" screws). Solid blocking on both sides at lock height is required.

Does this really work? What does effect does shrinkage have on the usefulness of the blocking to do the job? How critical is the exterior and interior sheathing on the stiffness? Will the frame and one inch deadbolt by itself provide enough protection against frame spread?

A study commissioned by CMHC tested a variety of construction details to evaluate the usefulness of different alternatives.

The stiffness of the wall is influenced by:

1. the properties of the sheathing membrane on each side of the wall
2. the properties of the framing members
3. the properties of the connection between the two
4. The ability for spreading forces to be transferred directly into the sheathing through bearing of the shims
5. the relative stiffness of the shim bearing
6. the effects of moisture and load cycling on the above
7. the boundary conditions of the wall panel



1: long screws; 2: blocking; 3: 1" throw deadbolt

Nine wall designs were tested. These included the use of blocking at lock height constructed both wet and dry.

Each sample was tested by forcing the wall 1" or to failure by means of a hand-operated hydraulic jack, with the intention of opening a 1" gap on the exterior, lock side of the door in less than 3 minutes.

The wall samples were built with stud-grade SPF lumber with an average moisture content between 15 and 20%. The lumber was selected on the basis of matching species and quality between wall specimens.

All samples had ½ inch gypsum board as interior finish with 1¼ inch drywall nails spaced 8 inches apart. None were insulated. All but one wall were tested after the moisture content had dried to below 12%.

Cedar wedges and foam insulation were used as shims to see how much of any gap was due to the distortion of the shim material. These were used by placing 3" wide cedar wedges at lock height or foam insulation the full height of the door.

An insulated steel door and wood jamb were installed in each test wall.

The Results?

Of the details tested, exterior waferboard sheathing had the greatest resistance to jamb spreading. (plywood should perform similarly to waferboard, but it was not tested).

It was found that the use of waferboard as exterior sheathing was more effective than blocking, extra studs, reduced nail spacing or gypsum board sheathing in providing resistance against jamb spreading.

There appears to be little difference in the resistance of a wall sheathed with waferboard if the nail spacing is decreased by half (in other words, more nails don't do anything extra).

Semi rigid sheathing products (such as Glasclad) do not provide protection against jamb spreading.

The use of blocking alone, installed wet or dry, has a small effect on the resistance to jamb spreading, (just enough to increase the resistance to a level that met the minimum required).

Wood framed walls with exterior gypsum board sheathing were better than steel stud walls.

The use of extra studs perpendicular to those framing the door opening, exterior gypsum board sheathing and reducing the spacing of nails in the interior gypsum board sheathing, all increased the resistance of the walls.

The resistance against jamb spreading of short, strong walls on the lock side of exterior doors is limited by the fastening of the bottom plate to the floor.

The recommendations:

For security purposes, in high crime rate areas, waferboard or plywood exterior sheathing on each side of exterior doors rather than blocking should be required.

The nailing requirements for fastening bottom plates to floors on each side of exterior doors should be increased to at least 4-3¼" nails.

Exterior gypsum board sheathing or an extra stud connected to the top and bottom plates with framing brackets should be considered as alternatives to increase security in residential areas with low to average crime rates.

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MARCH 2-4, 1989

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- *Easy-access panels for service from either side without core removal*

** According to independent lab. testing to CSA standard C439M.*
For further information, call or write:

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